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Long-Term Outcome in Patients With Inferior Myocardial Infarction and Complete Atrioventricular Block

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Some studies have reported increased short-term mortality and higher incidence of multivessel coronary artery disease in patients with inferior myocardial infarction and complete heart block, but information is lacking on clinical outcome after hospital discharge. Therefore, data were obtained and analyzed in 749 patients who were admitted with inferior myocardial infarction to four different centers and followed up for 1 year. Six hundred fifty-four patients (Group 1) did not have complete heart block and 95 (Group 2) had complete heart block during their hospital stay (incidence rate 12.8%).

Compared with Group 1, Group 2 patients were older (66 versus 61 years, $p < 0.01$), more often had signs of left ventricular failure ($p < 0.001$) and had higher peak creatine kinase values (1,840 versus 1,322 IU/liter, $p < 0.001$). The in-hospital mortality rate was higher in Group 2 than in Group 1 (24.2 versus 6.3%, $p < 0.001$). However, at discharge there was no difference between Group 1 and Group 2 in clinical characteristics, left ventricular ejection fraction (0.52 ± 0.12 versus 0.52 ± 0.11) or incidence of complex ventricular arrhythmias on ambulatory electrocardiographic monitoring. Furthermore, during the year after hospital discharge, patients in Groups 1 and 2 did not have significantly different mortality rates (6.4 versus 10.1%, p = NS). The incidence rate of reinfarction (4%) was the same in Groups 1 and 2. The incidence of coronary artery bypass surgery was slightly but not significantly higher in Group 1 compared with Group 2 (11 versus 4%).

It is concluded that patients with inferior myocardial infarction and complete heart block have a high in-hospital mortality. However, by multivariate analysis, the occurrence of complete heart block is no longer an independent predictor of poor prognosis after hospital discharge. Patients with complete heart block who survive to leave the hospital have a favorable clinical outcome.

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Complete atrioventricular (AV) block occurs in 9 to 12% of patients after inferior myocardial infarction (1,2). Several studies have reported a higher short-term mortality in such patients than in patients without heart block, even when the block is transient, as is typically the case (2–7). Some studies (2,7–9) have found a large infarction, as assessed by serum creatine kinase, and a high incidence of congestive heart failure in patients with inferior infarction and heart block, which may account for the increased early mortality. Furthermore, multivessel disease with high grade obstruction of the left anterior descending coronary artery was recently reported (10) in 10 of 11 patients who developed complete AV block after inferior myocardial infarction. Thus, the high incidence of early left ventricular failure and multivessel coronary disease in these patients could predict a poor outcome after hospital discharge, although the long-term clinical course has not been examined.

In the present study, we analyzed the in-hospital and 1 year clinical outcome in a large group of patients with inferior myocardial infarction with and without complete AV block.

Methods

Study patients. Seven hundred forty-nine patients, 570 men and 179 women aged 28 to 95 years (mean ± SD, 62 ± 12), who had an inferior or posterior myocardial infarction between 1979 and mid-1986, were included in this study. None of the patients underwent thrombolytic therapy or

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percutaneous coronary angioplasty. The diagnosis of inferior or posterior myocardial infarction was established by the presence in leads III and aVF of Q waves >0.04 s in duration or >25% of the R wave in depth or by the presence of initial monophasic R waves in lead V_1 or V_2 of ≥0.04 s with an R/S ratio >1 in the absence of right ventricular hypertrophy and at least one of the following: 1) chest pain considered characteristic of myocardial ischemia, and 2) elevation of total serum creatine kinase.

Patients were recruited from four centers: the University of California, San Diego Medical Center; the San Diego Veterans Administration Hospital; the Naval Hospital of San Diego and Vancouver General Hospital, British Columbia, Canada. Data concerning these patients were available in a data base maintained at the Specialized Center of Research on Ischemic Heart Disease at the University of California, San Diego Medical Center.

Clinical variables. The methods used for data acquisition and storage have been detailed previously (11,12). Selected variables were compared for patients with and without complete heart block after inferior myocardial infarction. Historical variables included age, gender, history of previous myocardial infarction, congestive heart failure, angina, hypertension, diabetes or smoking. Variables from physical examination included maximal heart rate, minimal systolic blood pressure and the maximal respiratory rate recorded during the stay in the coronary care unit. Left ventricular failure was also reported and defined by the presence of two of the following: S_3 gallop, bibasilar or higher pulmonary rales and ≥grade 2 pulmonary congestion on chest X-ray film as described previously (13).

Laboratory findings included maximal creatine kinase and blood urea nitrogen. Electrocardiographic (ECG) measurements included initial and maximal QRS duration. The presence of a new or old bundle branch block was also noted. Complete heart block (or third degree heart block) was defined by the failure of successive atrial impulses to reach the ventricles. It was differentiated from accelerated idioventricular or junctional rhythm with AV dissociation.

Left ventricular ejection fraction was measured in a subgroup of 414 patients with radionuclide ventriculography (363 patients) or cardiac catheterization (51 patients) before hospital discharge or ≤6 weeks after hospital discharge. Twenty-four hour ambulatory ECG monitoring was performed in 441 patients before hospital discharge. The presence of complex ventricular arrhythmias was defined as frequent ventricular premature beats (>1 beat/min or 30 beats/h), multiform ventricular premature beats, early ventricular premature beats (R on T phenomenon) or ventricular tachycardia (>3 consecutive ventricular premature beats at a rate of ≥100 beats/min). All medications including antiarrhythmic drugs were continued during the 24 h ambulatory ECG monitoring.

Determination of the left ventricular ejection fraction and 24 h ambulatory ECG monitoring were performed only if prescribed by the attending physician; no effort was made to perform these tests on any particular subgroup of patients. Only small differences in clinical characteristics between the patients with and without determination of ejection fraction and ambulatory ECG monitoring have been described previously (14).

Follow-up. Telephone interviews with all patients were obtained at 3, 6 and 12 months after the initial admission. Death certificates or hospital records were reviewed to clarify details. All information was reviewed by a committee, and a consensus decision was reached whenever doubt existed. Death was considered to be of cardiac origin when it occurred secondary to a new fatal myocardial infarction, extension of the myocardial infarction, congestive heart failure, shock, cardiac procedures or surgery and when it was sudden (due to documented fatal arrhythmias or sudden unexpected death with exact cause unknown but presumed to be of cardiac origin). Ninety-nine percent of all patients entered into the study were followed up for 1 year.

Statistical analysis. Continuous variables were expressed as mean ± values SD. Discrete variables were compared between groups using chi-square analysis, whereas continuous variables were compared with a *t* test. Multivariate analyses (linear discrimination) were carried out to assess the independent prognostic importance of individual variables after controlling for other variables. F ratios indicated the relative importance of each factor selected by the multivariate analysis after adjusting for all other factors selected (15). Survival curves for different groups of patients were compared with the Mantel-Cox statistical methods, as calculated by the survival function program (15).

Results

Incidence. Of the 769 patients admitted with inferior myocardial infarction, 654 (Group 1) did not have complete AV block and 95 (Group 2) developed complete block during their initial hospitalization. The block was transient in all except one patient who required insertion of a permanent pacemaker. The duration of complete AV block was <24 h in 47 patients, 24 to 48 h in 23, >48 h in 20 and not recorded in five.

Complete AV block occurred within 24 h of hospital admission in 66 patients (69%), within 24 to 48 h in 8 and after 48 h in 21. A temporary pacemaker was inserted in 67 patients (70%) (in 48 of these, AV block occurred within 24 h, in 6 between 24 and 48 h and in 13 after 48 h).

Clinical characteristics (Table 1). Clinical characteristics assessed during the coronary care unit period are shown in Table 1 for patients of both groups. Patients in Group 2 (with AV block) tended to be older, to be female, to have a more frequent history of congestive heart failure, to present more clinical and radiologic signs of left ventricular failure and to

Table 1. Clinical Characteristics of 749 Patients Admitted to the Hospital With Inferior Myocardial Infarction

n	No AVB (Group 1) (n = 654)		AVB (Group 2) (n = 95)
History			
Age (yr)	61 ± 12	**	66 ± 14
Male (%)	78	**	63
Previous MI (%)	22		23
CHF (%)	7	*	14
Angina (%)	31		37
Hypertension (%)	41		51
Diabetes (%)	13		17
Smoking			
Now (%)	53		54
Ever (%)	77		68
Physical examination			
Max HR (beats/min)	87 ± 16	*	92 ± 19
Min SBP (mm Hg)	102 ± 15	***	93 ± 19
Max respiratory rate (resp/min)	22 ± 4	***	24 ± 4
Left ventricular failure (%)	35	***	58
Laboratory			
Max CK (IU/liter)	1,322 ± 948	***	1,840 ± 1208
Max BUN (mg/dl)	21 ± 11	***	27 ± 16
Chest X-ray film			
Pulm congestion grade ≥2 (n = 673) (%)	20	**	34
ECG			
New and indet. BBB (%)	6	*	13
Old BBB (%)	5		5
Left BBB (%)	2		5

*p < 0.05; **p < 0.01; ***p < 0.001. AVB = complete atrioventricular block; BBB = bundle branch block; BUN = blood urea nitrogen; CHF = congestive heart failure; CK = creatine kinase; ECG = electrocardiogram; HR = heart rate; indet. = of indeterminate age Max = maximal; Min = minimal; MI = myocardial infarction; Pulm = pulmonary; SBP = systolic blood pressure.

Table 2. Clinical Characteristics of 684 Patients Discharged Alive After Inferior Myocardial Infarction

n	No AVB (Group 1) (n = 612)		AVB (Group 2) (n = 72)
History			
Age (yr)	61 ± 12	*	64 ± 14
Male (%)	82		67
Days in hospital	13.2 ± 6.3	***	17.3 ± 8.6
Physical examination			
S_3 (%)	4		8
Pulm bibasilar rales (%)	4		6
Chest X-ray rales (%)	4		6
Pulm congestion grade ≥ 2 (n = 486) (%)	4		0
Other studies			
Complex PVCs (%) (n = 441) (%)	41 (n = 384)		58 (n = 57)
LVEF (n = 414)	0.52 ± 0.12 (n = 363)		0.52 ± 0.11 (n = 51)
ECG			
QRS duration (s)	0.086 ± 0.018		0.083 ± 0.017
PR interval (s)	0.168 ± 0.030	***	0.191 ± 0.048
Medications			
Antiarrhythmic agents (%)	21	*	32
Beta-blockers (%)	46	**	25
Digitalis (%)	21	**	42
Diuretics (%)	26		34
Clinical events (%)			
Nonfatal reinfarction	4		4
CABG	11		4
Cardiac catheterization	12		4

*p < 0.05; **p < 0.01; *** p < 0.001; CABG = coronary artery bypass grafting; LVEF = left ventricular ejection fraction; PVC = premature ventricular complexes; other abbreviations as in Table 1.

have a larger infarct size. The incidence rate of new bundle branch block or bundle branch block of indeterminate age was higher in patients of Group 2 compared with those of Group 1 (13 versus 6%, respectively, $p < 0.05$). In Group 2, digoxin was used in eight patients and a beta-adrenergic blocking agent in nine other patients in the 48 h preceding the occurrence of the complete heart block. Only one patient received both digoxin and a beta-adrenergic blocking agent in the 48 h preceding complete heart block.

Table 2 lists clinical characteristics of survivors at the time of hospital discharge. The hospital stay of patients in Group 2 was longer than that of patients in Group 1, as expected. However, both groups were similar in the frequency of signs of left ventricular failure, the level of left ventricular ejection fraction and the prevalence of complex ventricular arrhythmias. Antiarrhythmic drugs and digitalis were given more frequently and a beta-adrenergic blocker less frequently to patients with complete heart block.

In-hospital clinical course. Twenty-three (24.2%) of the 95 patients in Group 2 died during the initial hospital stay compared with 41 (6.3%) of the 654 patients in Group 1 ($p < 0.001$). Similarily, of those with associated bundle branch block (new or of indeterminate age), 4 (33%) of 12 died in Group 2 compared with 3 (8%) of 38 in Group 1. Mortality was not dependent on the time of occurrence of the AV block. Of the 66 patients who had complete AV block within 24 h of admission, 17 (26%) died in the hospital. Of the eight patients in whom block occurred within 24 to 48 h, one (13%) died. Finally, 5 (24%) of the 21 patients with block occurring after 48 h died in the hospital. Mortality was also not dependent on the duration of the AV block, 13 (28%) of 47, 5 (22%) of 23 and 5 (25%) of 20 patients died in whom the duration of block was <24 h, 24 to 48 h and >48 h, respectively. The causes of death in both groups are shown in Figure 1. In Group 2, death was frequently due to congestive heart failure or cardiogenic shock, whereas sudden death was more common in Group 1.

Clinical course after hospital discharge (Table 2). In Group 1 (without AV block) and Group 2 (with AV block)

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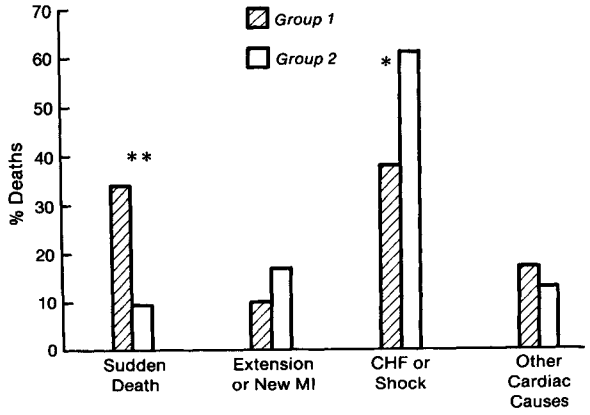


Figure 1. Causes of death during the hospital stay. Whereas sudden death was more common in Group 1 (** = $p < 0.05$), congestive heart failure (CHF) or shock was more common in Group 2 (* = $p < 0.07$). MI = myocardial infaction. Group 1 and Group 2 are patients without and with complete AV block, respectively.

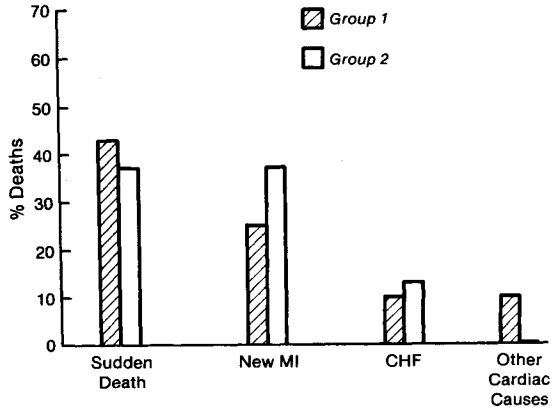
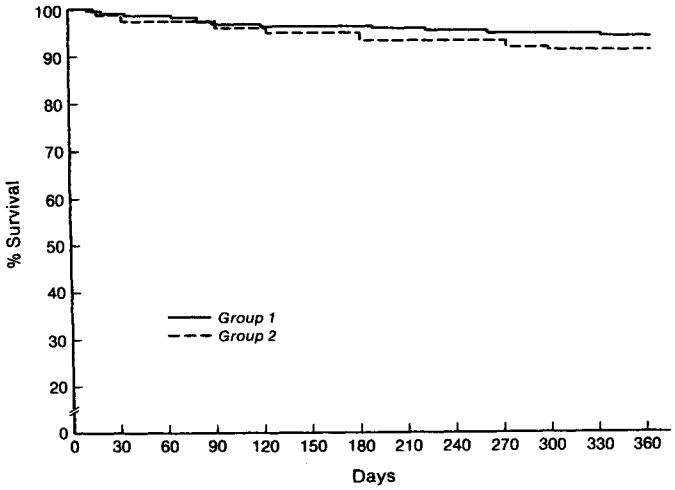


Figure 3. Causes of death in the patients of Group 1 and Group 2 were not different after hospital discharge. Abbreviations as in Figure 1.

the incidence of reinfarction (4 and 4%, respectively, p = NS) coronary artery bypass surgery (11 and 4%, respectively, p = NS) and cardiac catheterization (12 and 4%, p = NS) did not differ (Table 2). Survival after hospital discharge is shown in Figure 2. There was a trend toward increased mortality at 1 year in Group 2 compared with Group 1 (10.1 versus 6.4%, p = NS). Of the patients with bundle branch block (new or of indeterminate age) during their hospital stay, 6 (17%) of 35 in Group 1 and 2 (25%) of 8 in Group 2 died in the year after discharge (p = NS). Again, mortality after hospital discharge was not dependent on the time of in-hospital occurrence of the AV block or its duration. Causes of death were similar in both groups (Fig. 3).

Multivariate analysis (Table 3). After variables of left ventricular failure and other significant prognostic factors determined by univariate analysis were entered into the analysis, complete AV block showed some independent prognostic importance for in-hospital mortality. However, complete AV block was no longer a significant independent factor for prognosis in the year after hospital discharge.

Figure 2. Survival curves for patients of Group 1 and Group 2. Survival was good in both groups although slightly, but not significantly, better in Group 1.



Discussion

In-hospital prognosis of inferior infarction with complete AV block. In our series, the largest reported to date, 24% of patients with complete AV block after myocardial infarction died during the hospital stay. This is similar to the short-term mortality reported in other smaller studies. Chatterjee et al. (3) reported an in-hospital mortality rate of 23% in 65 patients with inferior myocardial infarction and AV block. Lassers and Julian (4) reported a 27% mortality rate and Gupta et al. (2) reported a 28% in-hospital mortality rate in such patients. In the series of Cohen et al. (5), 37% died within 2 months after inferior myocardial infarction and complete AV block. The lowest in-hospital mortality rate

Table 3. Multivariate Analysis of Prognostic Factors

	Order of Entry	F Ratio
In-hospital mortality		
Max BUN	1	44.0
Age	3	16.1
Min SBP	4	14.1
AVB	5	8.5
Max respiration rate	2	5.8
Heart failure	6	5.20
Mortality after discharge		
Max QRS duration	2	10.4
Heart failure	3	9.4
Max heart rate	1	5.1

Abbreviations as in Table 1.

(19%) was reported by Norris (6), whereas the highest rate (45%) was found by Kostuk and Beanlands (7).

The increased incidence of left ventricular failure and the larger infarct size found in our patients with inferior myocardial infarction and complete AV block compared with findings in patients without heart block has been reported by others (2,7–9). In the Kostuk and Beanlands series, all 15 patients who died showed either cardiogenic shock or severe left ventricular failure (7). Hypotension, congestive heart failure and shock were found more frequently by Gupta et al. (2) in patients with complete heart block than in those without. The larger infarct size and increased incidence of left ventricular failure in patients with complete heart block contribute to the increased in-hospital mortality seen in several studies including ours. However, in our study, multivariate analyses also showed that complete AV block was an independent predictor of increased in-hospital mortality even after factors such as signs of left ventricular failure were entered. The reason for this is unclear. It is possible that the loss of atrial contribution to ventricular filling during complete heart block contributes to further hemodynamic compromise and increased mortality, particularly in patients with right ventricular infarction (16). This is supported by the high incidence of congestive heart failure and shock as a cause of death in patients with complete heart block.

The presence of right ventricular infarction was not determined in our patients. Therefore, its influence on prognosis, particularly when associated with complete AV block, cannot be determined from our study. In the present analysis, the subgroup of patients with complete AV block and associated bundle branch block were not at particularly increased risk of death after myocardial infarction. Furthermore, the time of occurrence and duration of complete AV block had no significant influence on subsequent mortality.

Long-term prognosis. Despite the numerous studies showing increased in-hospital mortality in patients with inferior myocardial infarction and complete AV block, no data are available on long-term prognosis. The reported high incidence of early congestive heart failure (2,7–9) and multivessel coronary artery disease (10) in this group might predict an increased complication rate and mortality after discharge. Our data, however, do not support this hypothesis. The incidence of recurrent angina pectoris or myocardial infarction was similar in patients with and without complete AV block. Coronary bypass surgery was performed slightly more often in patients without than in those with complete heart block. Thus, even though multivessel coronary artery disease has been reported more frequently in patients with inferior myocardial infarction and complete AV block (10), the clinical evolution does not show an increased incidence of ischemic events in this group. Similarly, 1 year mortality after hospital discharge was only slightly and not significantly different between patients with inferior myocardial infarction with and without complete AV block. Furthermore, the causes of death after hospital discharge were similar in both groups, and multivariate analyses did not identify complete AV block as an independent factor for increased mortality in patients after hospital discharge.

Our study therefore does not support the view that survivors with inferior myocardial infarction and complete AV block are at very high risk after hospital discharge. Those patients who died had conventional factors predicting increased mortality, such as heart failure in the hospital, generally recognized to warrant coronary angiography (17). Therefore, coronary angiography and revascularization need not be recommended for all patients of this group but may be reserved for patients with conventional risk factors such as ongoing ischemia or left ventricular failure.

Limitations of study. A limited number of patients underwent coronary angiography in our study. Therefore, we cannot exclude the presence of increased severity of coronary artery disease in patients with inferior myocardial infarction and transient complete AV block. Furthermore, not all patients underwent determination of left ventricular ejection fraction or ambulatory ECG monitoring. However, the lack of an increased incidence of clinical events after hospital discharge in this group argues against major clinical differences between patients with and without complete heart block after inferior myocardial infarction who are discharged from the hospital.

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